WO 97/46034
PCT/FI97/00318

PATENT COOPERATION TREATY

09/194297

From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:

KOLSTER OY AB
Iso Roobertinkatu 23
P.O. Box 148
FIN-00121 Helsinki
FINLANDE

11 -12- 1997

Date of mailing (day/month/year) 04 December 1997 (04.12.97)	
Applicant's or agent's file reference 43131/PCT/ko	**IMPORTANT NOTICE**
International application No. PCT/FI97/00318	**International filing date** (day/month/year) 26 May 1997 (26.05.97)
Priority date (day/month/year) 27 May 1996 (27.05.96)	
Applicant NOKIA TELECOMMUNICATIONS OY et al	

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AU,BR,CA,CN,EP,IL,JP,KP,KR,NO,PL,SK,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AL,AM,AP,AT,AZ,BA,BB,BG,BY,CH,CU,CZ,DE,DK,EA,EE,ES,FI,GB,GE,GH,HU,IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MD,MG,MK,MN,MW,MX,NZ,OA,PT,RO,RU,SD,SE,SG,SI,TJ,TM,TR,TT,UA,UG,UZ,VN,YU
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   04 December 1997 (04.12.97) under No. WO 97/46034

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, **a demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer
J. Zahra

Telephone No. (41-22) 338.83.38

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00318

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/20, G01S 3/28, G01S 5/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0431956 A2 (MOTOROLA INC.), 12 June 1991 (12.06.91), column 4, line 31 - line 40; column 5, line 49 - line 52, claim 12	1-10
Y	US 5515419 A (E.A. SHEFFER), 7 May 1996 (07.05.96), column 9, line 8 - line 32, figure 7	1-10
Y	EP 0631453 A2 (TELIA AB), 2 June 1994 (02.06.94), column 3, line 19 - line 33, abstract	1-10
A	US 5508707 A (F.W. LEBLANC ET AL), 16 April 1996 (16.04.96), column 12, line 41 - column 13, line 19, figures 7-9	1-10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 Sept 1997	01 -10- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Per Källquist Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00318

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0320913 A2 (OY NOKIA AB), 21 June 1989 (21.06.89), claims 1,7, abstract -- --------	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/09/97

International application No.
PCT/FI 97/00318

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0431956 A2	12/06/91	US 5023900 A	11/06/91
		US 5095500 A	10/03/92
US 5515419 A	07/05/96	AU 3071295 A	04/03/96
		WO 9604155 A	15/02/96
		US 5568535 A	22/10/96
		EP 0643860 A	22/03/95
		JP 8501645 T	20/02/96
		US 5218367 A	08/06/93
		WO 9324911 A	09/12/93
EP 0631453 A2	02/06/94	SE 500769 C	29/08/94
		SE 9302140 A	29/08/94
		US 5564079 A	08/10/96
US 5508707 A	16/04/96	NONE	
EP 0320913 A2	21/06/89	AU 2706088 A	22/06/89
		DK 697788 D	00/00/00
		JP 1212377 A	25/08/89

PATENT COOPERATION TREATY

09/194297

PCT

24 SEP 1998

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
43131/PCT/nu		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI97/00318	26.05.1997	27.05.1996
International Patent Classification (IPC) or national classification and IPC_6		
H 04 Q 7/20, G 01 S 3/28 , G 01 S 5/02		
Applicant		
Nokia Telecommunications OY et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☐ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
05.12.1997	11.09.1998
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Telex 17978 PATOREG-S Facsimile No. 08-667 72 88	Authorized officer Per Källquist Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI97/00318

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☐ the international application as originally filed.

☒ the description, pages 1-10, as originally filed,
pages _____, filed with the demand,
pages _____, filed with the letter of _____,
pages _____, filed with the letter of _____.

☒ the claims, Nos. _____, as originally filed,
Nos. _____, as amended under Article 19,
Nos. _____, filed with the demand,
Nos. 1-8, filed with the letter of 04.08.1998,
Nos. _____, filed with the letter of _____.

☒ the drawings, ~~sheets~~/fig 1-4, as originally filed,
~~sheets~~/fig _____, filed with the demand
~~sheets~~/fig _____, filed with the letter of _____,
~~sheets~~/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, ~~sheets~~/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI97/00318

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application,

☒ claims Nos. 1-8

because:

☐ the said international application, or the said claims Nos. _____ relate to the following subject matter which does not require an international preliminary examination *(specify)*:

☐ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. _____ are so unclear that no meaningful opinion could be formed *(specify)*:

☐ the claims, or said claims Nos. _____ are so inadequately supported by the description that no meaningful opinion could be formed.

☒ no international search report has been estabilised for said claims Nos. 1-8

CLAIMS

(Amended on August 4, 1998)

1. A method for determining the position of a mobile station located in the coverage area of a base station in a radio system and for using said information, in which method the base station comprises equipment for receiving signals from the same mobile station simultaneously by at least two antenna beams (A) directed in different directions, and in which method:

the signal levels (B) of the signals received by the different antenna beams are measured,

the signal levels of the signals received from the same mobile station by the different antenna beams are compared (C, D, E),

the direction to the mobile station in relation to the base station is determined on the basis of the relations between the signal levels (F, G, H, I, J) measured for the different antenna beams, and

the distance from the mobile station to the base station is calculated on the basis of a timing advance (TA), given to the mobile station by the base station and the propagation speed of the radio signals, **characterized** in that

said distance and said direction is used for making a handover decision on the basis of the location of the mobile station.

2. A method according to claim 1, **characterized** in calculating a mean value for the measuring results during a determined time period (C) and determining the direction to the mobile station on the basis of the relations between the calculated mean values.

3. A method according to claim 1, **characterized** in choosing a beam by which signals with the strongest signal level have been received and at least one of the adjacent beams (D), comparing the measured signal levels for the antenna beams in question (E), and determining the direction to the mobile station on the basis of the relation between the signal levels for the chosen antenna beams.

4. A method according to claim 1, **characterized** in determining that the mobile station is located

- in the centre (A1) of the first chosen beam, if the signal level (RSSI1) of the signals received by the beam in question (1) is essentially

higher than the signal level (RSSI2) of the signals received by the other chosen antenna beam (2),

- in the border area (A2) between the antenna beams, if the signal level (RSSI1, RSSI2) of the signals received by the chosen antenna beams (1, 2) is substantially the same, and

- between (A3) the centre (A1) of the first chosen antenna beam (1) and the border zone (A2) of the beams (1, 2), if the signal level (RSSI1) of the signals received by the first antenna beam (1) is somewhat higher than the signal level (RSSI2) of the signals received by the other antenna beam.

5. Base station (BTS1) of a radio system, which base station comprises

antenna equipment (1 - 4, 6, 7) for receiving signals from a certain mobile station simultaneously by at least two antenna beams (1 - 4) directed in different directions,

measuring equipment (8) for measuring the signal levels of the signals received by the different antenna beams,

equipment for defining a timing advance (TA) for the mobile station (MS) which is in radio connection with the base station to compensate for a time lag caused by the distance between the mobile station and the base station, and

calculation means (9) which are responsive to the measuring equipment (8) for determining the direction from the base station (BTS1) to the mobile station (MS) on the basis of the relations of the signal levels measured for the different antenna beams (1 - 4) and which calculation means (9) comprise equipment for calculating the distance between the base station (BTS1) and the mobile station (MS) on the basis of the timing advance (TA) defined for the mobile station and the propagation speed of the radio signals, **characterized** in that

said calculation means are adapted to transmit said direction and said distance further in the system in order to be used for making handover decisions.

6. Base station according to claim 5, **characterized** in that the calculation means (9) are arranged for calculating for each beam (1 - 4) the mean value of the signal levels of the signals received from the mobile station (MS) by the respective antenna beams, whereby the calculation means (9) are arranged to determine the direction from the base station (BTS1) to the

mobile station (MS) on the basis of relations between the calculated mean values.

7. Base station according to claim 5, **characterized** in that the calculation means (9) include means for choosing the antenna beam (1) with the strongest signal level and at least one adjacent beam (2), whereby the calculating means (9) are arranged for determining the direction from the base station (BTS1) to the mobile station (MS) on the basis of the relations of the signal levels (RSSI1, RSSI2) of the signals received via the chosen antenna beams (1, 2).

8. Base station according to claim 5, **characterized** in that said base station is a base station (BTS1) of a cellular radio system divided into logical traffic channels in accordance with a TDMA principle.

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PTO/PCT Rec'd 23 NOV 1998

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/FI 97/00318

International Filing Date 26 MAY 1997 (26.05.97)

09/194297

The Finnish Patent Office
PCT International Application
Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 43131/PCT/ko

Box No. I TITLE OF INVENTION

Method for determining the position of a mobile station

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

NOKIA TELECOMMUNICATIONS OY
Keilalahdentie 4
FIN-02150 Espoo
Finland

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(i.e. country)* of nationality: FI

State *(i.e. country)* of residence: FI

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

PALLONEN Jorma
Pitkänsillanranta 7-9 E 128
FIN-00530 Helsinki
Finland

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(i.e. country)* of nationality: FI

State *(i.e. country)* of residence: FI

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

KOLSTER OY AB
Iso Roobertinkatu 23
P.O. Box 148
FIN-00121 Helsinki
Finland

Telephone No. 358-9-618821

Facsimile No. 358-9-602244

Teleprinter No. 122323 KOPAT FI

☐ Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

- [x] AP **ARIPO Patent:** KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SZ Swaziland, UG Uganda, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- [x] EA **Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- [x] EP **European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- [x] OA **OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

- [x] AL Albania
- [x] AM Armenia
- [x] AT Austria
- [x] AU Australia
- [x] AZ Azerbaijan
- [x] BA Bosnia and Herzegovina
- [x] BB Barbados
- [x] BG Bulgaria
- [x] BR Brazil
- [x] BY Belarus
- [x] CA Canada
- [x] CH and LI Switzerland and Liechtenstein
- [x] CN China
- [x] CU Cuba
- [x] CZ Czech Republic
- [x] DE Germany
- [x] DK Denmark
- [x] EE Estonia
- [x] ES Spain
- [x] FI Finland
- [x] GB United Kingdom
- [x] GE Georgia
- [x] HU Hungary
- [x] IL Israel
- [x] IS Iceland
- [x] JP Japan
- [x] KE Kenya
- [x] KG Kyrgyzstan
- [x] KP Democratic People's Republic of Korea
- [x] KR Republic of Korea
- [x] KZ Kazakstan
- [x] LC Saint Lucia
- [x] LK Sri Lanka
- [x] LR Liberia
- [x] LS Lesotho
- [x] LT Lithuania
- [x] LU Luxembourg
- [x] LV Latvia
- [x] MD Republic of Moldova
- [x] MG Madagascar
- [x] MK The former Yugoslav Republic of Macedonia
- [x] MN Mongolia
- [x] MW Malawi
- [x] MX Mexico
- [x] NO Norway
- [x] NZ New Zealand
- [x] PL Poland
- [x] PT Portugal
- [x] RO Romania
- [x] RU Russian Federation
- [x] SD Sudan
- [x] SE Sweden
- [x] SG Singapore
- [x] SI Slovenia
- [x] SK Slovakia
- [x] TJ Tajikistan
- [x] TM Turkmenistan
- [x] TR Turkey
- [x] TT Trinidad and Tobago
- [x] UA Ukraine
- [x] UG Uganda
- [x] US United States of America
- [x] UZ Uzbekistan
- [x] VN Viet Nam

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after issuance of this sheet:

- [x] YU Yugoslavia
- [x] GH Ghana
- [ ]
- [ ]

In addition to the designations made above, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except the designation(s) of _____.

The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)*

PCT/FI 97/00318

Box No. VI PRIORITY CLAIM Further priority claims are indicated in the Supplemental Box ☐

The priority of the following earlier application(s) is hereby claimed:

Country *(in which, or for which, the application was filed)*	Filing Date *(day/month/year)*	Application No.	Office of filing *(only for regional or international application)*
item (1) FI	(27.05.1996) 27 May 1996	962215	
item (2)			
item (3)			

Mark the following check-box if the certified copy of the earlier application is to be issued by the Office which for the purposes of the present international application is the receiving Office (a fee may be required):

☐ The receiving Office is hereby requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s) : _____

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(If two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):* ISA / SE

Earlier search *Fill in where a search (international, international-type or other) by the International Searching Authority has already been carried out or requested and the Authority is now requested to base the international search, to the extent possible, on the results of that earlier search. Identify such search or request either by reference to the relevant application (or the translation thereof) or by reference to the search request:*

Country (or regional Office): Date *(day/month/year)*: Number:

Box No. VIII CHECK LIST

This international application contains the following number of sheets:

1. request	3	sheets
2. description	10	sheets
3. claims	3	sheets
4. abstract	1	sheets
5. drawings	3	sheets
Total	20	sheets

This international application is accompanied by the item(s) marked below:

1. ☐ separate signed power of attorney
2. ☐ copy of general power of attorney
3. ☐ statement explaining lack of signature
4. ☐ priority document(s) *identified in Box No. VI as item(s):*
5. ☒ fee calculation sheet
6. ☐ separate indications concerning deposited microorganisms
7. ☐ nucleotide and/or amino acid sequence listing (diskette)
8. ☒ other *(specify)*: Copy of Official Action

Figure No. 2 of the drawings (if any) should accompany the abstract when it is published.

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

KOLSTER OY AB

by

Antti Peltonen

For receiving Office use only

1. Date of actual receipt of the purported international application: 26 MAY 1997 (26-05-1997)
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority specified by the applicant: ISA / SE
6. ☐ Transmittal of search copy delayed until search fee is paid

For International Bureau use only

Date of receipt of the record copy by the International Bureau: 10 JUNE 1997

Menetelmä matkaviestimen sijainnin selvittämiseksi

Tämän keksinnön kohteena on menetelmä radiojärjestelmän tukiaseman peittoalueella sijaitsevan matkaviestimen sijainnin selvittämiseksi, jossa menetelmässä tukiasema käsittää välineitä saman matkaviestimen lähettämien signaalien vastaanottamiseksi samanaikaisesti ainakin kahdella eri suuntiin suunnatulla antennikeilalla, ja jossa menetelmässä: mitataan eri antennikeiloilla vastaanotettujen signaalien signaalitasoja, verrataan samalta matkaviestimeltä eri antennikeiloilla vastaanotettujen signaalien signaalitasoja keskenään, ja päätellään suunta jossa matkaviestin sijaitsee tukiaseman suhteen eri antennikeilojen osalta mitattujen signaalintasojen suhteiden perusteella. Keksinnön kohteena on lisäksi radiojärjestelmän tukiasema, joka käsittää antennivälineitä signaalien vastaanottamiseksi määrätyltä matkaviestimeltä samanaikaisesti ainakin kahdella eri suuntiin suunnatulla antennikeilalla, mittausvälineitä eri antennikeiloilla vastaanotettujen signaalien signaalitasojen mittaamiseksi, mittausvälineille vasteelliset laskinvälineet suunnan määrittämiseksi tukiasemalta matkaviestimelle eri antennikeilojen osalta mitattujen signaalitasojen suhteiden perusteella, ja välineitä ajoitusennakon nimeämiseksi tukiasemaan radiosignaaleilla yhteydessä olevalle matkaviestimelle tämän ja tukiaseman välisen etäisyyden aiheuttamien ajallisen viiveen kompensoimiseksi.

Käsitteellä eri suuntiin suunnatuilla antennikeiloilla tarkoitetaan tässä yhteydessä, että tukiaseman kattama radiosolu on jaettu vierekkäisiin sektoreihin joista vastaanotetaan samaan loogiseen kanavaan liittyviä signaaleja (sama taajuuskanava ja aikaväli), ja että jokaiseen sektoriin on suunnattu suunta-antenni tai vastaava, jolla voidaan vastaanottaa kyseisestä sektorista lähtöisin olevia signaaleja. Tukiaseman antennit on kuitenkin

edullisesti suunnattu siten, että ne limittyvät ainakin osittain niiden välisillä raja-vyöhykkeillä.

Keksintö liittyy solukkoradiojärjestelmän, esimerkiksi GSM-järjestelmän (Groupe Spécial Mobile) matkaviestimen sijainnin selvittämiseen. Ennestään tunnetaan ratkaisuja, joissa matkaviestimen sijainti on selvitetty tarkastamalla esimerkiksi GSM-järjestelmän matkapuhelinkeskuksen HLR-rekisteristä (Home Location Register) missä radiosolussa matkaviestin määrätyllä hetkellä sijaitsee. Tämän tunnetun ratkaisun merkittävin heikkous on kuitenkin sen epätarkkuus. Eli koska edellä mainitussa tunnetussa ratkaisussa saadaan selville ainoastaan missä radiosolussa matkaviestin sijaitsee, riippuu luonnollisesti matkaviestimen paikantamistarkkuus suoraan kyseisen radiosolun koosta. Radiosolujen koko vuorostaan riippuu täysin radiojärjestelmän ominaisuuksista, mutta esimerkiksi GSM-järjestelmässä tällaisen radiosoluun perustuvan paikantamisen epätarkkuus voi tyypillisesti olla useita kilometrejä.

Käytännössä on kuitenkin esiintynyt tarvetta siihen, että matkaviestimen sijainti voitaisiin selvittää suuremmalla tarkkuudella. Esimerkiksi kanavanvaihdon (handover) yhteydessä olisi tarpeellista selvittää matkaviestimen tarkka maantieteellinen sijainti. Nykyisellään kanavanvaihto perustuu mm. GSM-järjestelmässä vastaanotettujen signaalien signaalitasoon ja laatuun, eikä suinkaan matkaviestimen sijaintiin. Näin ollen hetkelliset radiohäiriöt saattavat johtaa tarpeettomaan kanavanvaihto-operaatioon, eli matkaviestin siirretään solusta toiseen kun signaalitaso tai laatu alittaa ennalta määrätyn rajan, jonka jälkeen kanavanvaihto-operaatio toistetaan mutta päinvastaiseen suuntaan eli matkaviestin palautetaan alkuperäiseen soluun häiriön vaikutuksen päätyttyä.

Eräs toinen tilanne, jossa olisi tarpeen selvittää matkaviestimen tarkka sijainti liittyy varastetun matka-

viestimen tai esimerkiksi SIM-kortin (Subscriber Identity Module) paikantamiseen. Tunnetuissa ratkaisuissa, joissa matkaviestimen paikantamisen epätarkkuus on suuruusluokaltaan useita kilometrejä, on käytännössä varastetun matkaviestimen paikantaminen lähes mahdotonta.

Tämän keksinnön tarkoitus on ratkaista edellä mainitut ongelmat ja saada aikaan entistä tarkempi menetelmä matkaviestimen sijainnin selvittämiseksi. Tämä päämäärä saavutetaan keksinnön mukaisella menetelmällä, jolle on tunnusomaista, että lasketaan etäisyys matkaviestimeltä tukiasemalle tukiaseman matkaviestimelle nimeämän ajoitusennakon ja radiosignaalien etenemisnopeuden perusteella.

Keksinnön kohteena on lisäksi tukiasema, jonka avulla keksinnön mukaista menetelmää voidaan soveltaa. Keksinnön mukaiselle tukiasemalle on tunnusomaista, että laskinvälineisiin kuuluu välineitä tukiaseman ja matkaviestimen välisen etäisyyden laskemiseksi matkaviestimelle nimetyn ajoitusennakon sekä radiosignaalien etenemisnopeuden perusteella.

Keksintö perustuu siihen ajatukseen, että matkaviestimen sijainti voidaan selvittää merkittävästi suuremmalla tarkkuudella kuin ennestään tunnetuissa ratkaisuissa kun sen signaaleja vastaanotetaan ainakin kahdella keskenään eri suuntiin suunnatulla antennikeilalla ja kun verrataan miten hyvin matkaviestimen lähettämät signaalit kuuluvat eri keiloilla. Eli matkaviestimen lähettämät signaalit kuuluvat normaalisti parhaiten sillä antennikeilalla, joka on suunnattu suoraan kohti matkaviestintä. Näin ollen saadaan selville minkä keilan sisällä matkaviestin sijaitsee. Kun lisäksi tiedetään mihin suuntaan kyseinen keila on suunnattu voidaan suunta matkaviestimeen helposti selvittää. Se miten lähellä kyseisen keilan keskiosaa tai vastaavasti reunaosia matkaviestin sijaitsee, voidaan selvittää vertaamalla kyseisellä keilalla vastaanotettujen

signaalien signaalitasoa "pääkeilalla" vastaanotettujen signaalien signaalitasoon. Näin ollen suunta tukiasemalta matkaviestimelle voidaan selvittää eri keiloilla vastaanotettujen signaalien signaalitasosuhteiden avulla. Tämän lisäksi etäisyys matkaviestimeltä tukiasemalle voidaan keksinnön mukaisesti laskea tukiaseman matkaviestimelle nimeämän ajoitusennakon ja radiosignaalien etenemisnopeuden perusteella. Esimerkiksi GSM-järjestelmässä on jo ennestään käytössä niin sanottu ajoitusennakko (Timing Advance), jonka tukiasema ilmoittaa matkaviestimelle, jotta tämä tietäisi miten paljon sen tulisi ennenaikaistaa signaaliensa lähettämistä jotta signaalit saapuisivat oikealla hetkellä ja oikeassa aikavälissä tukiasemalle matkaviestimen ja tukiaseman välisestä etäisyydestä huolimatta. Tukiaseman matkaviestimelle nimeämä ajoitusennakko kuvaa näin ollen aikaa joka kuluu siitä kun matkaviestin on lähettänyt signaalin kunnes kyseinen signaali on perillä tukiasemalla. Näin ollen ajoitusennakon perusteella voidaan arvioida tukiaseman ja matkaviestimen välistä etäisyyttä kun signaalien etenemisnopeus on tiedossa.

Keksinnön mukaisen ratkaisun merkittävin etu on näin ollen, että matkaviestimen sijainti, eli sekä suunta että etäisyys tukiasemaan nähden, voidaan selvittää merkittävästi aiempaa tarkemmin mikä muun muassa mahdollistaa kanavanvaihtopäätösten tekemisen matkaviestimen sijainnin perusteella, jolloin turhilta kanavanvaihdoilta vältytään, sekä esimerkiksi varastetun matkapuhelimen paikantamisen entistä tarkemmin.

Jotta hetkelliset häiriöt eivät pääsisi merkittävästi vaikuttamaan matkaviestimen sijainnin selvittämiseen lasketaan eräässä keksinnön mukaisen menetelmän edullisessa suoritusmuodossa antennikeilakohtaista keskiarvoa määrätyltä matkaviestimeltä vastaanotettujen signaalien signaalitasoille määrätyn pituisen aikajakson ajan, jolloin matkaviestimen sijainti selvitetään laskettujen keskiarvo-

jen suhteiden perusteella.

Keksinnön mukaisen menetelmän ja tukiaseman edulliset suoritusmuodot ilmenevät oheisista epäitsenäisistä patenttivaatimuksista 2-4 ja 6-8.

Keksintöä selostetaan seuraavassa lähemmin muutaman edullisen suoritusmuodon avulla viitaten oheisiin kuvioihin, joista

kuvio 1 esittää vuokaaviota keksinnön mukaisen menetelmän ensimmäisestä edullisesta suoritusmuodosta,

kuvio 2 havainnollistaa keksinnön mukaisen tukiaseman ensimmäistä edullista suoritusmuotoa,

kuvio 3 esittää suurennosta kuvion 2 tukiaseman vastaanottokeiloista, ja

kuvio 4 esittää lohkokaaviota kuvion 2 tukiasemasta.

Kuvio 1 esittää vuokaaviota keksinnön mukaisen menetelmän ensimmäisestä edullisesta suoritusmuodosta. Kuvion 1 vuokaaviota voidaan soveltaa esimerkiksi GSM-järjestelmän tukiasemassa matkaviestimen sijainnin selvittämiseksi.

Lohkossa A vastaanotetaan signaaleja matkaviestimeltä MS useamman keskenään eri suuntiin suunnatun antennikeilan välityksellä. Käytettävät antennikeilat ovat edullisesti suhteellisen kapeita keiloja jotka on suunnattu siten, että ne ainakin osittain limittyvät (vertaa kuvio 2).

Lohkossa B mitataan vastaanotetun signaalin signaalitaso RSSI (Received Signal Strength Indication) kunkin keilan kautta vastaanotetuille signaaleille.

Lohkossa C lasketaan keilakohtainen keskiarvo ennalta määrätyn mittaisen aikajakson sisällä mitatuille RSSI-arvoille. Laskemalla keskiarvo RSSI-arvoille vältytään siltä että hetkelliset häiriöt pääsisivät vaikuttamaan matkaviestimen sijainnin selvittämiseen. Esimerkiksi GSM-järjestelmässä voidaan kyseinen aikajakso voidaan valita siten, että keskiarvo lasketaan muutamalle matkaviestimeltä vastaanotetulle purskeelle.

Lohkossa D valitaan ensimmäinen keila jonka RSSI keskiarvo (=RSSI1) on korkein. Tämän lisäksi valitaan ainakin yksi kyseisen keilan naapurikeiloista toiseksi keilaksi, jolloin valitaan edullisesti se naapurikeila, jolla on korkeampi RSSI keskiarvo (=RSSI2).

Lohkossa E verrataan eri keilojen RSSI-arvoja keskenään laskemalla valittujen keilojen RSSI keskiarvojen suhde RSSI1/RSSI2.

Lohkossa F tarkistetaan onko keilojen RSSI suhde suurempi kuin ennalta määrätty vertailuarvo K. Vertailuarvo on valittu siten, että se on olennaisesti suurempi kuin 1. Jos RSSI suhde ylittää vertailuarvon merkitsee tämä, että matkaviestin kuuluu merkittävästi paremmin ensimmäisen valitun keilan kautta kuin toisen valitun keilan kautta, mikä merkitsee, että matkaviestin sijaitsee ensimmäisen keilan keskiosan suunnassa. Tällöin siirrytään lohkoon G, jossa selvitetään suunta jonne ensimmäinen valittu keila on suunnattu, eli suunta jossa matkaviestin sijaitsee.

Lohkossa H tarkistetaan jos RSSI suhde on lähes 1. Mikäli näin on merkitsee se, että matkaviestin kuuluu lähes yhtä hyvin molempien valittujen keilojen kautta. Tämä vuorostaan merkitsee, että matkaviestin sijaitsee keilojen välisessä rajavyöhykkeessä. Tällöin siirrytään lohkoon I jossa selvitetään suunta jossa valittujen keilojen välinen rajavyöhyke (ja matkaviestin) sijaitsee.

Mikäli keilojen RSSI suhde ei ole suurempi kuin vertailuarvo K eikä keilojen RSSI suhde ole lähes 1 siirrytään lohkoon J. Tällöin todetaan että matkaviestin kuuluu jonkin verran paremmin ensimmäisen valitun keilan kautta kuin toisen valitun keilan kautta, mikä merkitsee että matkaviestin sijaitsee ensimmäisen valitun keilan keskiosan ja valittujen keilojen välisen rajavyöhykkeen välissä. Mikäli on tarpeellista arvioida suunta matkaviestimelle vielä tätäkin tarkemmin, voidaan kyseinen suunta

arvioida keilojen välisen RSSI-suhteen avulla. Tämä edellyttää etukäteen suoritettavien mittausten tekemistä, jotta saataisiin täsmällinen kuva siitä miten keilojen välinen RSSI-suhde muuttuu matkaviestimen siirtyessä keilojen väliseltä rajavyöhykkeeltä kohti ensimmäisen keilan keskiosaa.

Kuvion 1 vuokaaviota noudattamalla saadaan selville ainoastaan suunta tukiasemalta matkaviestimelle. Tämän lisäksi voi olla tarpeen saada selville myös etäisyys tukiasemalta matkaviestimelle. Keksinnön mukaisesti kyseinen etäisyys voidaan laskea tukiaseman matkaviestimelle nimeämän ajoitusennakon perusteella, eli

etäisyys = ajoitusennakko * radiosignaalien nopeus

Se tarkkuus millä matkaviestimen sijainti tukiaseman suhteen saadaan selville riippuu luonnollisesti käytettyjen antennikeilojen leveydestä sekä siitä tarkkuudesta, jolla tukiasema laskee matkaviestimelle ajoitusennakon. Esimerkiksi GSM-järjestelmässä voidaan kuitenkin edellä selostetulla tavalla selvittää matkaviestimen sijainti tyypillisesti noin 0,5 x 0,5 km tarkkuudella, kun tukiaseman antennikeilojen leveys on noin 30°.

Kuvio 2 havainnollistaa keksinnön mukaisen tukiaseman ensimmäistä suoritusmuotoa. Kuvion 2 tukiasema BTS1 voi olla esimerkiksi GSM-järjestelmän tukiasema, joka käsittää välineitä matkaviestimen MS lähettämien signaalien vastaanottamiseksi kuvion esitetystä radiosolusta samanaikaisesti neljällä vastaanottokeilalla 1-4. Kuviossa 2 on havainnollistettu radiosolun rajaa katkoviivoilla R.

Kuvion 2 matkaviestin MS sijaitsee keilojen 1 ja 2 välisellä rajavyöhykkeellä, minkä vuoksi se kuuluu lähes yhtä hyvin sekä keilalla 1 että keilalla 2. Eli tukiasema BTS1 laskema RSSI suhde keilojen 1 ja 2 osalta on lähes 1.

Kuvio 3 esittää suurennosta kuvion 3 tukiaseman

vastaanottokeiloista 1 ja 2. Oletetaan että tukiasema BTS1 on vastaanottanut signaalitasoltaan voimakkaimmat signaalit keilan 1 kautta. Tällöin kyseiset signaalit lähettänyt matkaviestin sijaitsee keilan 1 kattamalla alueella. Mikäli matkaviestin sijaitsee keilan 1 keskiosassa, eli kuvion 3 viivoitetulla alueella A1 havaitsee tukiasema tämän siten, että keilan 1 osalta mitatut RSSI arvot ovat merkittävästi suuremmat kuin keilan 2 osalta mitatut RSSI arvot. Eli keilojen RSSI suhde on olennaisesti suurempi kuin 1.

Mikäli matkaviestin sijaitsee keilojen välisellä rajavyöhykkeellä A2 havaitsee tukiasema tämän siten, että keilojen 1 ja 2 osalta on mitattu olennaisesti samansuuruiset RSSI arvot, eli keilojen RSSI suhde on lähes 1.

Mikäli matkaviestin sijaitsee keilan 1 keskiosan A1 ja keilojen 1 ja 2 välisen rajavyöhykkeen A2 välissä, eli alueella A3 havaitsee tukiasema BTS1 tämän siten, että keilan 1 osalta mitatut RSSI arvot ovat jonkin verran suurempia kuin keilan 2 osalta mitatut RSSI arvot.

Kuvio 4 esittää lohkokaaviota kuvion 2 tukiasemasta. Tukiaseman BTS1 antennikeiloilla 1-4 vastaanottamat samaan loogiseen kanavaan liittyvät signaalit syötetään kaistanpäästösuodattimien 7 ja vahvistimien 6 kautta tukiaseman RSSI-vastaanottimelle 8. Kuviossa 4 RSSI-vastaanotin 8 on esitetty tukiaseman yhteydessä, mutta kaapeloinnin helpottamiseksi RSSI-vastaanotin voidaan sovittaa myös tukiaseman antennimastoon jonkin antennielementin yhteyteen.

RSSI-vastaanottimessa on kuvion 4 tapauksessa 4 tuloa ja yksi lähtö. RSSI vastaanotin valitsee sen tuloihin syötetyistä signaaleista yhden edelleen välitettäväksi sen lähdön kautta tukiaseman vastaanottimelle RX. Kuvion 4 tukiasemassa RSSI-vastaanotin 8 valitsee edelleen välitettävän signaalin mittaamalla kunkin antennikeilan 1-4 kautta vastaanotetuille signaaleille signaalitason RSSI sekä valitsemalla sen keilan, jolle on mitattu suurin RSSI

arvo. Vaihtoehtoisesti RSSI-vastaanotin voi suorittaa keilan valinnan myös jollakin toisella tavalla, kuten ottamalla RSSI-arvon lisäksi huomioon myös jonkin signaalin laatua kuvaavan arvon kuten bittivirhesuhteen BER. Tällainen ratkaisu kuitenkin monimutkaistaa RSSI-vastaanottimen rakennetta.

Mikäli käytetään sellaista vastaanotinta joka kykenee toteuttamaan diversiteettivastaanottoa, voi RSSI-vastaanottimessa olla kaksi lähtöä, jolloin RSSI-vastaanotin valitsee käyttöön kaksi parasta antennikeilaa sekä välittää niiden välityksellä vastaanotetut signaalit edelleen tukiaseman varsinaiselle vastaanottimelle. Tällaisella järjestelyllä voidaan saavuttaa noin 3 dB parannus sektoreiden välisellä rajavyöhykkeellä sijaitsevan matkaviestimen signaalien vastaanotossa.

Keksinnön mukaisesti RSSI-vastaanotin 8 syöttää eri keiloille mitatut RSSI arvot laskimelle 9. Laskin 9 voi muodostua esimerkiksi matkaviestimen paikantamiseksi tukiasemaan lisätystä prosessorista sekä tietokoneohjelmasta.

Laskin 9 laskee mittaustulosten perusteella antennikeilakohtaista keskiarvoa vastaanotetuille signaaleille. Koska kuvion 4 tukiasema on GSM-järjestelmän tukiasema, jossa taajuuskanavat on jaettu aikaväleihin TDMA-periaatteella, laskee laskin 9 antennikeilakohtaisen keskiarvon erikseen jokaiselle loogiselle kanavalle. Tämän jälkeen laskin selvittää suunnan tukiasemalta matkaviestimelle kuten kuvion 1 vuokaaviossa on esitetty.

Laskimelle 9 syötetään keksinnön mukaisesti myös tukiaseman matkaviestimelle nimeämää ajoitusennakkoa (Timing Advance) kuvaavaa signaalia TA. Kyseisen signaalin perusteella laskin laskee etäisyyden matkaviestimeen kuten kuvion 1 vuokaavion yhteydessä on selostettu.

Laskimen lähdöstä syötettävä signaali POS ilmaisee näin ollen matkaviestimen sijainnin tukiasemaan nähden

(suunta + etäisyys) kyseinen tiedon perusteella voidaan esimerkiksi kanavanvaihto-operaatiot (handover) ajoittaa entistä paremmin, koska ne tällöin perustuvat matkaviestimen paikkatietoon. Lisäksi matkaviestimen sijaintia kuvaava paikkatieto voidaan välittää edelleen tukiasemaohjaimen ja matkapuhelinkeskuksen kautta verkonhallintakeskukseen, jolloin operaattori voi verkonhallintakeskuksesta käsin entistä tarkemmin selvittää matkaviestimen sijainnin.

On ymmärrettävä, että edellä oleva selitys ja siihen liittyvät kuviot on ainoastaan tarkoitettu havainnollistamaan esillä olevaa keksintöä. Näin ollen keksinnön mukaista ratkaisua voidaan soveltaa myös muissa solukkoradiojärjestelmissä kuin yksinomaan GSM-järjestelmässä. Alan ammattimiehille tulevat olemaan ilmeisiä myös muut erilaiset keksinnön variaatiot ja muunnelmat ilman että poiketaan oheisissa patenttivaatimuksissa esitetyn keksinnön suojapiiristä ja hengestä.

Patenttivaatimukset:

1. Menetelmä radiojärjestelmän tukiaseman peittoalueella sijaitsevan matkaviestimen sijainnin selvittämiseksi, jossa menetelmässä tukiasema käsittää välineitä saman matkaviestimen lähettämien signaalien vastaanottamiseksi samanaikaisesti ainakin kahdella eri suuntiin suunnatulla antennikeilalla (A), ja jossa menetelmässä:

mitataan eri antennikeiloilla vastaanotettujen signaalien signaalitasoja (B),

verrataan samalta matkaviestimeltä eri antennikeiloilla vastaanotettujen signaalien signaalitasoja keskenään (C, D, E), ja

päätellään suunta jossa matkaviestin sijaitsee tukiaseman suhteen eri antennikeilojen osalta mitattujen signaalintasojen suhteiden perusteella (F, G, H, I, J),

t u n n e t t u siitä, että

lasketaan etäisyys matkaviestimeltä tukiasemalle tukiaseman matkaviestimelle nimeämän ajoitusennakon ja radiosignaalien etenemisnopeuden perusteella.

2. Patenttivaatimuksen 1 mukainen menetelmä, t u n n e t t u siitä, että lasketaan mittaustuloksille keskiarvo määrätyn aikajakson aikana (C) ja päätellään suunta, jossa matkaviestin sijaitsee laskettujen keskiarvojen suhteiden perusteella.

3. Patenttivaatimuksen 1 mukainen menetelmä, t u n n e t t u siitä, että valitaan keila jonka kautta on vastaanotettu signaalitasoltaan voimakkaimmat signaalit sekä ainakin yksi tämän keilan naapurikeiloista (D), verrataan kyseisille antennikeiloille mitattuja signaalitasoja keskenään (E), ja päätellään suunta, jossa matkaviestin sijaitsee valittujen antennikeilojen signaalitasojen suhteen perusteella.

4. Patenttivaatimuksen 1 mukainen menetelmä, t u n n e t t u siitä, että päätellään matkaviestimen sijait-

sevan

- ensimmäisen valitun keilan keskiosassa (A1), jos kyseisellä keilalla (1) vastaanotettujen signaalien signaalitaso (RSSI1) on olennaisesti korkeampi kuin toisella valitulla antennikeilalla (2) vastaanotettujen signaalien signaalitaso (RSSI2),

- antennikeilojen välisessä rajavyöhykkeessä (A2), jos valituilla antennikeiloilla (1, 2) vastaanotettujen signaalien signaalitaso (RSSI1, RSSI2) on olennaisesti sama, ja

- ensimmäisen valitun antennikeilan (1) keskiosan (A1) ja keilojen (1, 2) välisen rajavyöhykkeen (A2) välissä (A3), jos ensimmäisellä keilalla (1) vastaanotettujen signaalien signaalitaso (RSSI1) on jonkin verran suurempi kuin toisella antennikeilalla vastaanotettujen signaalien signaalitaso (RSSI2).

5. Radiojärjestelmän tukiasema (BTS1), joka käsittää

antennivälineitä (1-4, 6, 7) signaalien vastaanottamiseksi määrätyltä matkaviestimeltä samanaikaisesti ainakin kahdella eri suuntiin suunnatulla antennikeilalla (1-4),

mittausvälineitä (8) eri antennikeiloilla vastaanotettujen signaalien signaalitasojen mittaamiseksi,

mittausvälineille (8) vasteelliset laskinvälineet (9) suunnan määrittämiseksi tukiasemalta (BTS1) matkaviestimelle (MS) eri antennikeilojen (1-4) osalta mitattujen signaalitasojen suhteiden perusteella, ja

välineitä ajoitusennakon (TA) nimeämiseksi tukiasemaan radiosignaaleilla yhteydessä olevalle matkaviestimelle (MS) tämän ja tukiaseman välisen etäisyyden aiheuttamien ajallisen viiveen kompensoimiseksi, t u n n e t t u siitä, että

laskinvälineisiin (9) kuuluu välineitä tukiaseman (BTS1) ja matkaviestimen (MS) välisen etäisyyden laskemiseksi matkaviestimelle nimetyn ajoitusennakon (TA) sekä

radiosignaalien etenemisnopeuden perusteella.

6. Patenttivaatimuksen 5 mukainen tukiasema, t u n n e t t u siitä, että laskinvälineet (9) on sovitettu laskemaan antennikeilakohtaista (1-4) keskiarvoa mainitulta matkaviestimeltä (MS) eri antennikeiloilla vastaanotettujen signaalien signaalitasoista, jolloin laskinvälineet (9) on sovitettu määrittämään suunnan tukiasemalta (BTS1) matkaviestimelle (MS) laskettujen keskiarvojen suhteiden perusteella.

7. Patenttivaatimuksen 5 mukainen tukiasema, t u n n e t t u siitä, että laskinvälineisiin (9) kuuluu välineitä signaalitasoltaan voimakkaimman antennikeilan (1) valitsemisesi sekä ainakin yhden naapurikeilan (2) valitsemiseksi, jolloin laskinvälineet (9) on sovitettu määrittämään suunnan tukiasemalta (BTS1) matkaviestimelle (MS) valittujen antennikeilojen (1, 2) kautta vastaanotettujen signaalien signaalitasojen (RSSI1, RSSI2) suhteen perusteella.

8. Patenttivaatimuksen 5 mukainen tukiasema, t u n n e t t u siitä, että mainittu tukiasema on TDMA-periaatteella loogisiin liikennekanaviin jaetun solukkoradiojärjestelmän tukiasema (BTS1).

(57) Tiivistelmä

Tämän keksinnön kohteena on radiojärjestelmän tukiasema (BTS1), joka käsittää antennivälineitä (1-4) signaalien vastaanottamiseksi määrätyltä matkaviestimeltä samanaikaisesti ainakin kahdella eri suuntiin suunnatulla antennikeilalla (1-4), ja mittausvälineitä eri antennikeiloilla vastaanotettujen signaalien signaalitasojen mittaamiseksi. Jotta matkaviestimen (MS) sijainti saataisiin selville entistä tarkemmin käsittää tukiasema (BTS1) mittausvälineille vasteelliset laskinvälineet suunnan määrittämiseksi tukiasemalta (BTS1) matkaviestimelle (MS) eri antennikeilojen (1-4) osalta mitattujen signaalitasojen suhteiden perusteella.

Kuvio 2

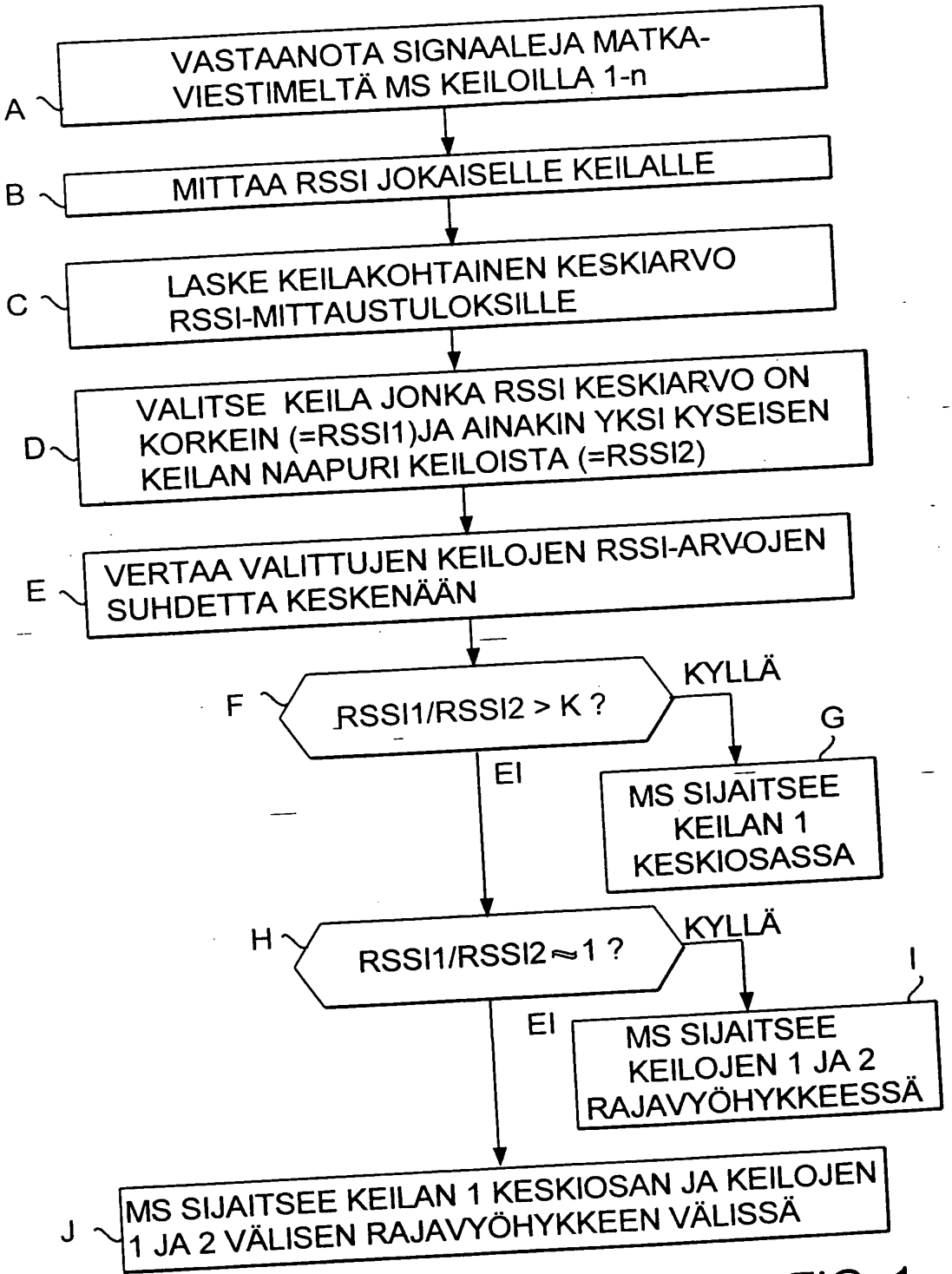
A
VASTAANOTA SIGNAALEJA MATKA-VIESTIMELTÄ MS KEILOILLA 1-n
B
MITTAA RSSI JOKAISELLE KEILALLE
C
LASKE KEILAKOHTAINEN KESKIARVO RSSI-MITTAUSTULOKSILLE
D
VALITSE KEILA JONKA RSSI KESKIARVO ON KORKEIN (=RSSI1)JA AINAKIN YKSI KYSEISEN KEILAN NAAPURI KEILOISTA (=RSSI2)
E
VERTAA VALITTUJEN KEILOJEN RSSI-ARVOJEN SUHDETTA KESKENÄÄN
F
RSSI1/RSSI2 > K ?
KYLLÄ
G
MS SIJAITSEE KEILAN 1 KESKIOSASSA
EI
H
RSSI1/RSSI2≈1 ?
KYLLÄ
I
MS SIJAITSEE KEILOJEN 1 JA 2 RAJAVYÖHYKKEESSÄ
EI
J
MS SIJAITSEE KEILAN 1 KESKIOSAN JA KEILOJEN 1 JA 2 VÄLISEN RAJAVYÖHYKKEEN VÄLISSÄ

FIG. 1

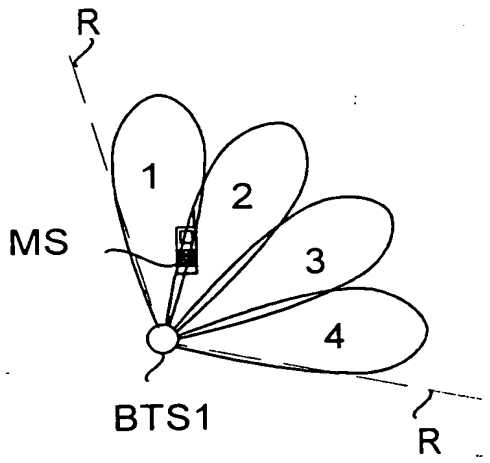

FIG. 2

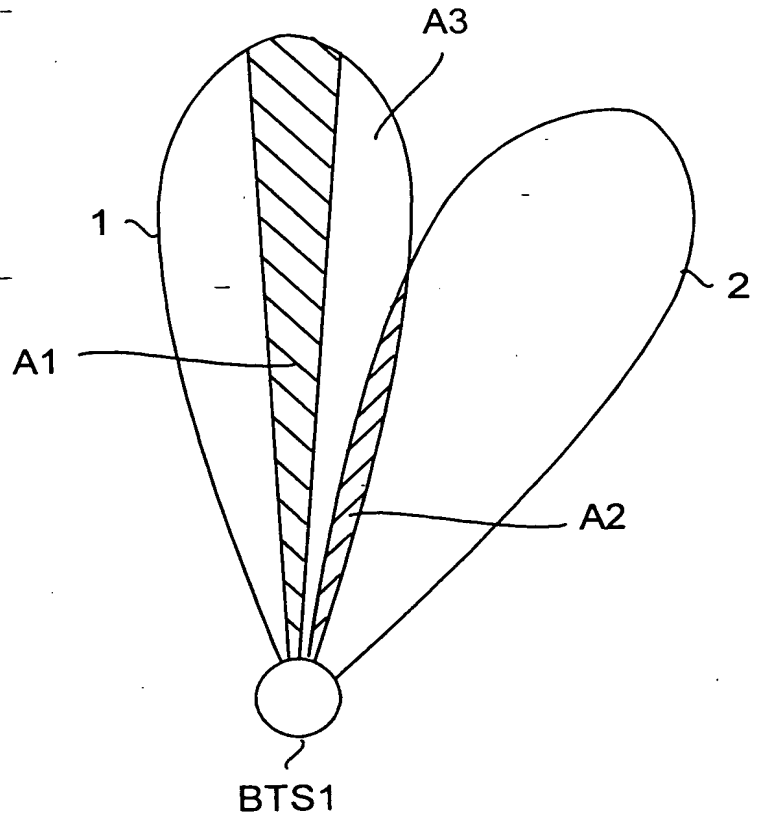

FIG. 3

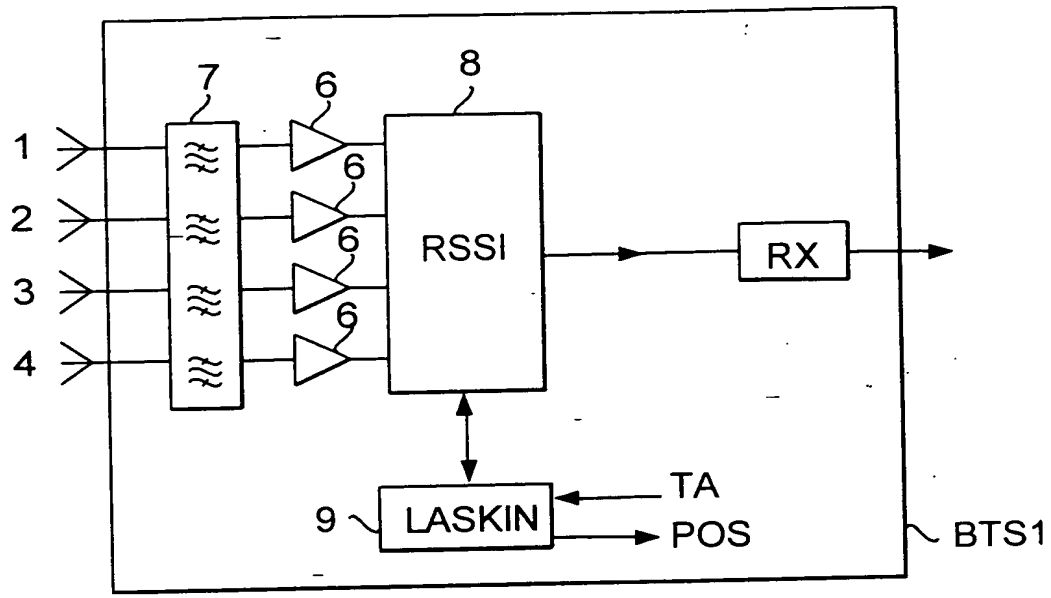

FIG. 4

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(71) Applicant *(for all designated States except US)*: NOKIA TELECOMMUNICATIONS OY [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: PALLONEN, Jorma [FI/FI]; Pitkänsillanranta 7-9 E 128, FIN-00530 Helsinki (FI).

(74) Agent: KOLSTER OY AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).

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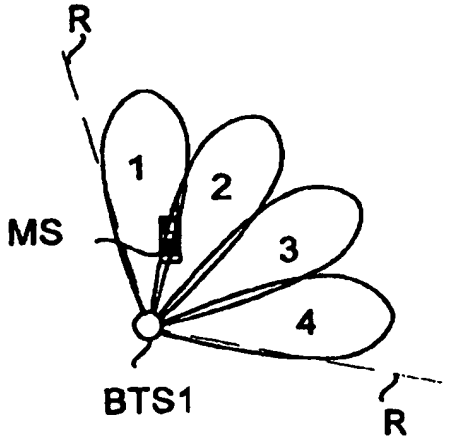
(54) Title: METHOD FOR DETERMINING THE POSITION OF A MOBILE STATION

(57) Abstract

The present invention relates to a base station (BTS1) of a cellular radio system, which base station comprises antenna equipment (1-4) for receiving signals from a certain mobile station simultaneously by at least two antenna beams (1-4) directed in different directions, and measuring equipment for measuring the signal levels of the signals received by the respective antenna beams. For determining the position of the mobile station (MS) with greater accuracy the base station (BTS1) is provided with calculating means which are responsive to the measuring equipment to determine the direction from the base station (BTS1) to the mobile station (MS) by calculating the relations between the signal levels of the signals for the respective beams.



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METHOD FOR DETERMINING THE POSITION OF A MOBILE STATION

The invention relates to a method for determining the position of a mobile station located in the coverage area of a base station in a radio system, in which method the base station comprises equipment for receiving signals from the same mobile station simultaneously by at least two antenna beams directed in different directions, and in which method: the signal levels of the signals received by the different antenna beams are measured, the signal levels of the signals received from the same mobile station by the different antenna beams are compared, and the direction to the mobile station in relation to the base station is determined on the basis of the relations between the signal levels measured for the different antenna beams. The invention further relates to a base station of a radio system, which base station comprises antenna equipment for receiving signals from a certain mobile station simultaneously by at least two antenna beams directed in different directions, measuring equipment for measuring the signal levels of the signals received by the different antenna beams, calculation means which are responsive to the measuring equipment for determining the direction from the base station to the mobile station on the basis of the relations of the signal levels measured for the different antenna beams, and equipment for defining a timing advance for the mobile station, which is in radio connection with the base station, to compensate for a time lag caused by the distance between the mobile station and the base station.

By the notion antenna beams turned in different directions is here meant that the radio cell covered by the base station is divided into adjacent sectors from which signals related to the same logical channel (the same frequency channel and time slot) are received, and that a directional antenna or the equivalent is directed to each sector, by which antenna signals can be received from the sector in question. The antennas of the base station are, however, preferably directed so that they overlap at least partly in the border zones between them.

The invention relates to determining of the position of a mobile station in a cellular radio system, e.g. the GSM system (Groupe Spécial Mobile). Prior solutions are known where the position of the mobile station has, for example, been determined by checking from the home location register (HLR) of the mobile switching centre of the GSM-system in which radio cell the mobile

station is located at a certain moment. The most significant problem with this known solution is its inaccuracy. Since it can only be ascertained in which radio cell the mobile station is located in the known solutions mentioned before, the accuracy of determining the position, of course, directly depends on the size of the radio cell in question. The size of the radio cells again totally depends on the properties of the radio system, but in the GSM system, for example, the inaccuracy of determining the position according to the radio cell can typically be several kilometers.

However, in practice there has been a need for greater accuracy in determining the position of a mobile station. For example in connection with handover operations it would be necessary to determine the exact geographical position of the mobile station. At present handover is, for instance in the GSM system, based on the signal level and quality of the signals received, and by no means on the position of the mobile station. Thus temporary radio disturbances can lead to an unnecessary handover operation, i.e. the mobile station is transferred from one cell to another when the signal level or quality falls below a predetermined level, after which the handover operation is repeated but in the reverse direction, i.e. the mobile station is returned to the original cell when the disturbance is over

Another situation where it would be necessary to determine the exact position of the mobile station is when a stolen mobile station or for example a SIM Card (Subscriber Identity Module) is to be located. In known solutions, where the inaccuracy in locating the mobile station is several kilometers, it is practically impossible to determine the position of a stolen mobile station.

The object of the present invention is to solve the above mentioned problems and to achieve a more precise method for determining the position of a mobile station. This aim is achieved by the method of the invention, which is characterized in calculating the distance from the mobile station to the base station on the basis of a timing advance given to the mobile station by the base station and the propagation speed of the radio signals.

The invention also relates to a base station by which the method of the invention can be carried out. A base station according to the invention is characterized in that the calculation means comprise equipment for calculating the distance between the base station and the mobile station on the basis of the timing advance defined for the mobile station and the propagation speed of the radio signals.

The invention is based on the realization that the position of the mobile station can be determined with significantly greater accuracy than in known solutions when its signals are received by at least two antenna beams directed in different directions and when the audibility of the signals received by the respective beams from the mobile station is compared. In other words, the audibility of the signals transmitted by the mobile station is normally best for the beam that is directed straight towards the mobile station. Thus it can be determined within which beam the mobile station is located. When it is further known in which direction the beam in question is turned the direction to the mobile station can easily be determined. How near the centre or respectively the edges of the beam the mobile station is located can be determined by comparing the signal levels of the signals received by the beam in question to the signal levels of the signals received by "the principal beam". Thus the direction from the base station to the mobile station can be determined from the relation between the signal levels of the signals received by the respective beams. In addition to this the distance from the mobile station to the base station can, according to the invention, be calculated on the basis of a timing advance given to the mobile station by the base station and the propagation speed of the radio signals. In the GSM system, for example, there is already in use a so called timing advance TA given by the base station to the mobile station to inform it of how much in advance it should transmit its signals so that the signals will arrive at the right moment and in the proper time slot to the base station regardless of the distance between the mobile station and the base station. Thus, the distance between the base station and the mobile station can be determined on the basis of the timing advance when the propagation speed of the signals is known.

The most significant advantage with the solution of the invention is thus that the position of the mobile station, that is both its direction and distance from the base station, can be determined with significantly greater accuracy than previously, which among other things makes it possible to make handover decisions on the basis of the location of the mobile station, whereby unnecessary handover operations can be avoided, and for example to locate a stolen mobile station with greater accuracy than before.

So that temporary disturbances would not significantly disturb the determining of the position of the mobile station, in a preferred embodiment of the invention the mean value of the signal levels of the signals received by the

respective antennas from a certain mobile station is calculated for a certain time period, whereby the position of the mobile station is determined on the basis of the mean values of the calculated relations.

The preferred embodiments of the method and base station of the invention are revealed in the attached dependent claims 2 - 4 and 6 - 8.

In the following the invention will be described in more detail in a few preferred embodiments by mean of the attached drawings, in which

Figure 1 shows a flowchart of a first preferred embodiment of the method of the invention,

Figure 2 illustrates a first preferred embodiment of a base station of the invention,

Figure 3 shows an enlargement of the receiving beams of the base station in Figure 2, and

Figure 4 shows a block diagram of the base station in Figure 2.

Figure 1 shows a block diagram of a first preferred embodiment of the method of the invention. The block diagram in Figure 1 can, for example, be applied in a base station of the GSM system to determine the position of a mobile station.

In block A signals are received from a mobile station MS by several antenna beams directed in different directions. The antenna beams used are preferably relatively narrow beams that are directed so that they at least partly overlap (compare with Figure 2).

In block B the received signal strength indication RSSI of the received signal is measured for the signals received by the respective beams.

In block C a mean value is calculated for the RSSI values measured within a certain time span for each beam. By calculating the mean value for the RSSI values it can be avoided that temporary disturbances influence the locating of the mobile station. For example in the GSM system the time span in question can be chosen so that the mean value is calculated for a few bursts received from the mobile station.

In block D a first beam is chosen which has the highest RSSI mean value (=RSSI1). In addition to this at least one of the adjacent beams is chosen as a second beam, whereby preferably the beam with the higher RSSI mean value (=RSSI2) is chosen.

In block E the RSSI values for the different beams are compared by calculating the ratio of the RSSI mean values RSSI1/ RSSI2 for the chosen

beams.

In block F it is checked if the RSSI ratio for the beams is greater than the predetermined reference value K. The reference value is chosen so that it is essentially greater than 1. If the RSSI ratio exceeds the reference value that denotes that the audibility of the mobile station is much better by the first chosen beam than by the second chosen beam, which means that the mobile station is located in the direction of the centre of the first beam. Hereby a transfer is made to block G, where the direction of the first chosen beam is specified, which is the direction where the mobile station is located.

In block H it is checked if the RSSI ratio is nearly 1. If that is the case it denotes that the audibility of the mobile station is almost equally good via both the chosen beams. This again means that the mobile station is located in the border zone between the two beams. Hereby a transfer is made to block I, where the direction is specified where the border zone between the beams (and the mobile station) is located.

Provided that the RSSI ratio of the beams is not greater than the reference value K, neither the RSSI ratio nearly 1, a transfer is made to block J. Thus it is ascertained that the audibility of the mobile station is somewhat better via the first chosen beam than via the second chosen beam, which means that the mobile station is located between the centre of the first chosen beam and the border zone between the chosen beams. If it is necessary to determine the direction to the mobile station more accurately than that, the direction in question can be determined by the RSSI ratio of the beams. That requires measurements made in advance so that a precise picture can be had of how the RSSI ratio between the beams changes when the mobile station moves from the border zone between the beams to the centre of the first beam.

By following the flowchart in Figure 1 only the direction from the base station to the mobile station can be determined. In addition to this it can be necessary also to determine the distance from the base station to the mobile station. According to the invention the distance in question can be calculated on the basis of the timing advance given to the mobile station by the base station, that is

distance = timing advance * propagation speed of the radio signals

How accurately the position of the mobile station can be determined in relation to the base station of course depends on the width of the antenna beams used and how accurately the base station calculates the timing advance for the mobile station. For example in the GSM system the position of the mobile station can be determined as described above with an accuracy of typically about 0,5 x 0,5 km, when the width of the antenna beams is about 30°.

Figure 2 illustrates a first embodiment of a base station of the invention. The base station BTS1 in Figure 2 can, for example, be a base station in the GSM system, which base station comprises equipment for receiving signals transmitted by the mobile station MS from the radio cell in the figure simultaneously by four receiving beams 1 - 4. In Figure 2 the boundaries of the radio cell have been illustrated by a dash line R.

The mobile station MS of Figure 2 is located in the border zone between beams 1 and 2, whereby its audibility is almost as good by beam 1 as by beam 2. That is the RSSI ratio for beams 1 and 2 calculated by the base station BTS1 is nearly 1.

Figure 3 shows an enlargement of the receiving beams 1 and 2 of the base station in Figure 3. It is assumed that the base station BTS1 has received the signals with greater signal strength via beam 1. In that case the mobile station that has transmitted the signals in question is located in the area covered by beam 1. If the mobile station is located in the centre of beam 1, that is in the striped area A1 in Figure 3, the base station will recognize that as the calculated RSSI values for beam 1 are considerably greater than those for beam 2. That is the RSSI ratio is essentially greater than 1.

If the mobile station is located in the border zone A2 between the beams the base station will recognize that as the RSSI values calculated for beams 1 and 2 are essentially as great, that is the RSSI ratio is nearly 1.

If the mobile station is located between the centre A1 of beam 1 and the border area between beams 1 and 2, that is in the area A3, the base station will recognize that as the RSSI values measured for beam 1 are somewhat greater than the RSSI values measured for beam 2.

Figure 4 shows a block diagram of the base station in Figure 2. The signals related to the same logical channel that are received by the base station BTS1 by the antenna beams 1 - 4 are fed through band-pass filters 7 and amplifiers 6 to the RSSI receiver 8 of the base station. In Figure 4 the RSSI

receiver 8 is shown in connection with the base station, but to facilitate cabling the RSSI receiver can also be arranged in connection with an antenna element in the antenna mast of the base station.

In the example in Figure 4 there are 4 inputs and one output. The RSSI receiver chooses one of the signals fed into its inputs for further transmission via its output to the receiver RX of the base station. In the base station in Figure 4 the RSSI receiver 8 chooses a signal for further transmission by measuring the signal level RSSI for the signals received by each antenna beam 1 - 4 and by choosing the beam for which the greatest RSSI value has been measured. Alternately the RSSI receiver can choose the beam also in some other way, by also including a value representing signal quality like the bit error ratio BER in addition to the RSSI value. A solution like that will, however, complicate the construction of the RSSI receiver.

If such a receiver is used that can manage diversity reception, the RSSI receiver can have two outputs, whereupon the RSSI receiver chooses the two best antenna beams for use and transmits the signals received by these further to the actual receiver of the base station. With an arrangement like this an improvement of about 3 dB can be achieved in the reception of signals from a mobile station in the border zone between the sectors.

According to the invention the RSSI receiver 8 feeds the RSSI values measured for the respective beams to the calculator 9. The calculator 9 can for example be a processor and a computer program added to the base station for locating the mobile station.

The calculator 9 calculates the mean value of the received signals for each antenna beam on the basis of the measuring results. Since the base station in Figure 4 is a base station of the GSM system, where the frequency channels have been divided into time slots according to the TDMA principle, the calculator 9 first calculates a mean value for each antenna beam separately for each logical channel. After this the calculator specifies the direction from the base station to the mobile station as shown in the flowchart in Figure 1.

A signal denoting the timing advance TA given to the mobile station by the base station is according to the invention also fed to the calculator 9. On the basis of this signal the calculator calculates the distance to the mobile station as described in connection with the flowchart in Figure 1.

The signal POS fed from the output of the calculator thus denotes

the position of the mobile station in relation to the base station (direction + distance). For instance handover operations can be timed better on the basis of this information, since they are then based on information about the position of the mobile station. Additionally the information about the position of the mobile station can be transmitted further via the base station controller and the mobile switching centre to the network management centre, whereupon the operator can determine the position of the mobile station with even greater accuracy from the network management centre.

It is to be understood that the above description and the related drawings are only intended to illustrate the present invention. Thus the invention can also be applied in other cellular radio systems than the GSM system. To those skilled in the art various other modifications and variations of the invention will be apparent within the scope and spirit of the present invention disclosed in the attached claims.

CLAIMS

1. A method for determining the position of a mobile station located in the coverage area of a base station in a radio system, in which method the base station comprises equipment for receiving signals from the same mobile station simultaneously by at least two antenna beams (A) directed in different directions, and in which method:

the signal levels (B) of the signals received by the different antenna beams are measured,

the signal levels of the signals received from the same mobile station by the different antenna beams are compared (C, D, E), and

the direction to the mobile station in relation to the base station is determined on the basis of the relations between the signal levels (F, G, H, I, J) measured for the different antenna beams, **characterized** in

calculating the distance from the mobile station to the base station on the basis of a timing advance (TA), given to the mobile station by the base station and the propagation speed of the radio signals.

2. A method according to claim 1, **characterized** in calculating a mean value for the measuring results during a determined time period (C) and determining the direction to the mobile station on the basis of the relations between the calculated mean values.

3. A method according to claim 1, **characterized** in choosing a beam by which signals with the strongest signal level have been received and at least one of the adjacent beams (D), comparing the measured signal levels for the antenna beams in question (E), and determining the direction to the mobile station on the basis of the relation between the signal levels for the chosen antenna beams.

4. A method according to claim 1, **characterized** in determining that the mobile station is located

- in the centre (A1) of the first chosen beam, if the signal level (RSSI1) of the signals received by the beam in question (1) is essentially higher than the signal level (RSSI2) of the signals received by the other chosen antenna beam (2),

- in the border area (A2) between the antenna beams, if the signal level (RSSI1, RSSI2) of the signals received by the chosen antenna beams (1, 2) is substantially the same, and

- between (A3) the centre (A1) of the first chosen antenna beam (1) and the border zone (A2) of the beams (1, 2), if the signal level (RSSI1) of the signals received by the first antenna beam (1) is somewhat higher than the signal level (RSSI2) of the signals received by the other antenna beam.

5. Base station (BTS1) of a radio system, which base station comprises

antenna equipment (1 - 4, 6, 7) for receiving signals from a certain mobile station simultaneously by at least two antenna beams (1 - 4) directed in different directions,

measuring equipment (8) for measuring the signal levels of the signals received by the different antenna beams,

calculation means (9) which are responsive to the measuring equipment (8) for determining the direction from the base station (BTS1) to the mobile station (MS) on the basis of the relations of the signal levels measured for the different antenna beams (1 - 4), and

equipment for defining a timing advance (TA) for the mobile station (MS) which is in radio connection with the base station to compensate for a time lag caused by the distance between the mobile station and the base station, **characterized** in that

the calculation means (9) comprise equipment for calculating the distance between the base station (BTS1) and the mobile station (MS) on the basis of the timing advance (TA) defined for the mobile station and the propagation speed of the radio signals.

6. Base station according to claim 5, **characterized** in that the calculation means (9) are arranged for calculating for each beam (1 - 4) the mean value of the signal levels of the signals received from the mobile station (MS) by the respective antenna beams, whereby the calculation means (9) are arranged to determine the direction from the base station (BTS1) to the mobile station (MS) on the basis of relations between the calculated mean values.

7. Base station according to claim 5, **characterized** in that the calculation means (9) include means for choosing the antenna beam (1) with the strongest signal level and at least one adjacent beam (2), whereby the calculating means (9) are arranged for determining the direction from the base station (BTS1) to the mobile station (MS) on the basis of the relations of the

signal levels (RSSI1, RSSI2) of the signals received via the chosen antenna beams (1, 2).

8. Base station according to claim 5, **characterized** in that said base station is a base station (BTS1) of a cellular radio system divided into logical traffic channels in accordance with a TDMA principle.

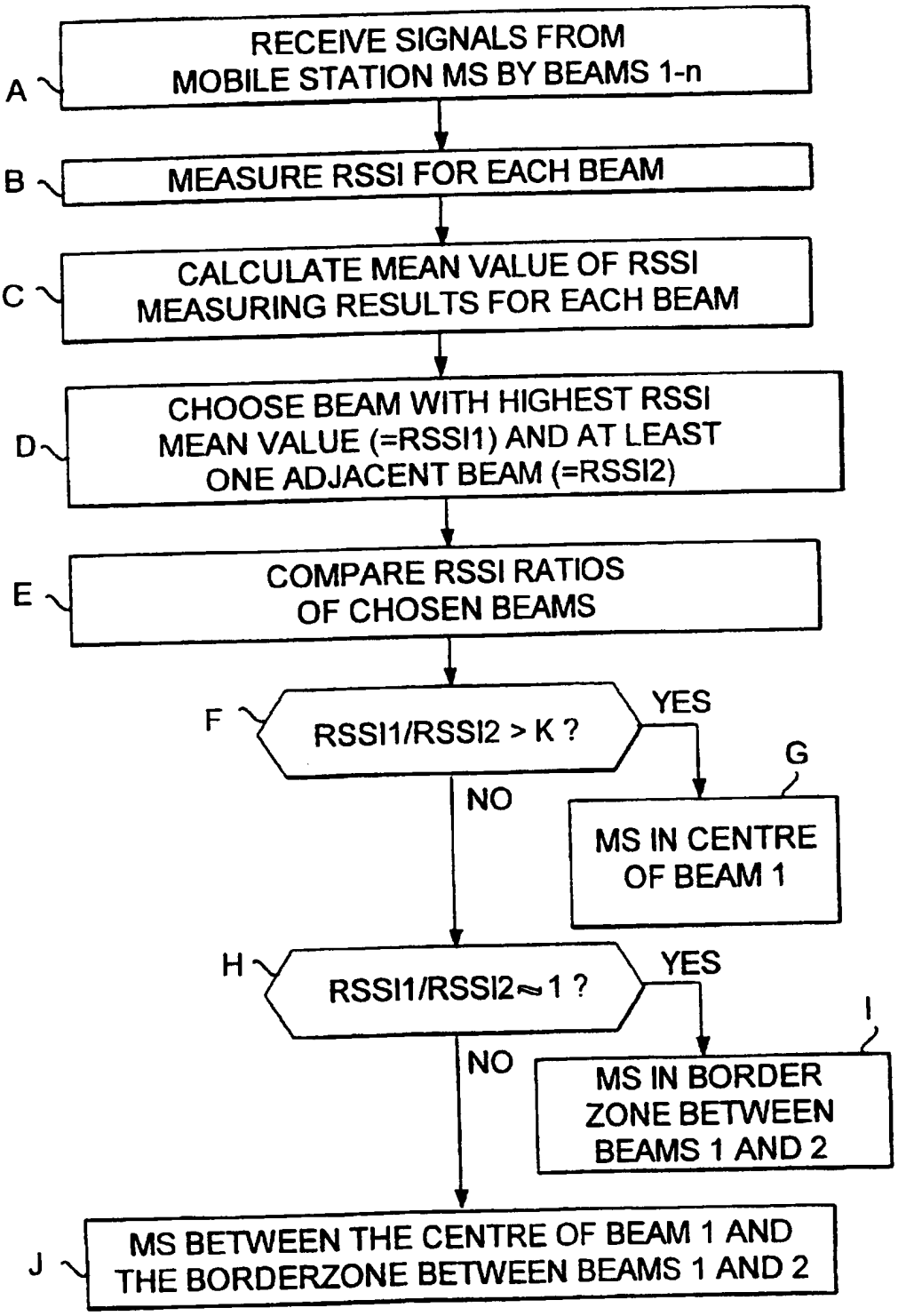
A
RECEIVE SIGNALS FROM MOBILE STATION MS BY BEAMS 1-n
B
MEASURE RSSI FOR EACH BEAM
C
CALCULATE MEAN VALUE OF RSSI MEASURING RESULTS FOR EACH BEAM
D
CHOOSE BEAM WITH HIGHEST RSSI MEAN VALUE (=RSSI1) AND AT LEAST ONE ADJACENT BEAM (=RSSI2)
E
COMPARE RSSI RATIOS OF CHOSEN BEAMS
F
RSSI1/RSSI2 > K ?
YES
NO
G
MS IN CENTRE OF BEAM 1
H
RSSI1/RSSI2≈1 ?
YES
NO
I
MS IN BORDER ZONE BETWEEN BEAMS 1 AND 2
J
MS BETWEEN THE CENTRE OF BEAM 1 AND THE BORDERZONE BETWEEN BEAMS 1 AND 2

FIG. 1

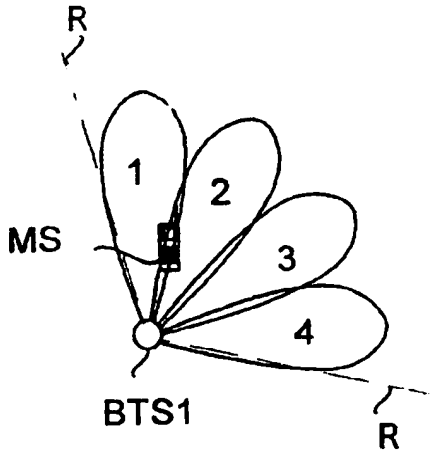

FIG. 2

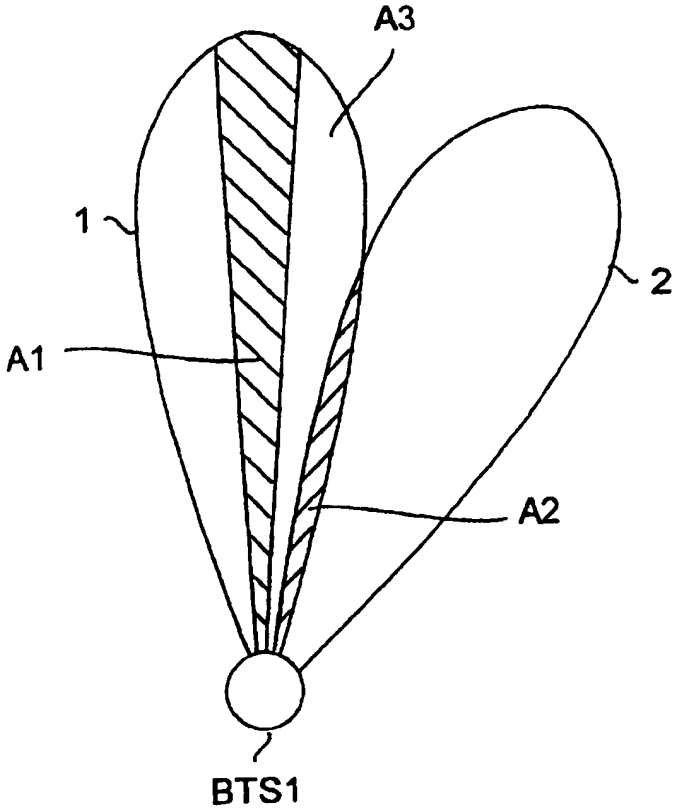

FIG. 3

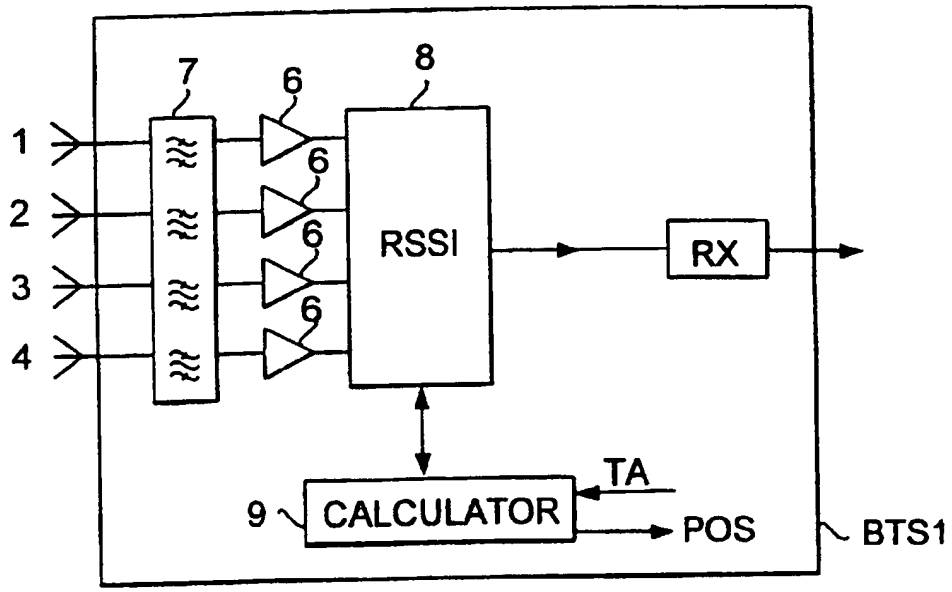

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00318

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/20, G01S 3/28, G01S 5/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0431956 A2 (MOTOROLA INC.), 12 June 1991 (12.06.91), column 4, line 31 - line 40; column 5, line 49 - line 52, claim 12 --	1-10
Y	US 5515419 A (E.A. SHEFFER), 7 May 1996 (07.05.96), column 9, line 8 - line 32, figure 7 --	1-10
Y	EP 0631453 A2 (TELIA AB), 2 June 1994 (02.06.94), column 3, line 19 - line 33, abstract --	1-10
A	US 5508707 A (F.W. LEBLANC ET AL), 16 April 1996 (16.04.96), column 12, line 41 - column 13, line 19, figures 7-9 --	1-10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 Sept 1997	01-10-1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Per Källquist Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00318

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0320913 A2 (OY NOKIA AB), 21 June 1989 (21.06.89), claims 1,7, abstract -- --------	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/09/97

International application No.
PCT/FI 97/00318

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		US 5095500 A	10/03/92
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		WO 9324911 A	09/12/93
EP 0631453 A2	02/06/94	SE 500769 C	29/08/94
		SE 9302140 A	29/08/94
		US 5564079 A	08/10/96
US 5508707 A	16/04/96	NONE	
EP 0320913 A2	21/06/89	AU 2706088 A	22/06/89
		DK 697788 D	00/00/00
		JP 1212377 A	25/08/89